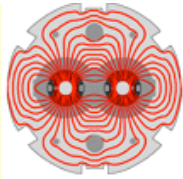




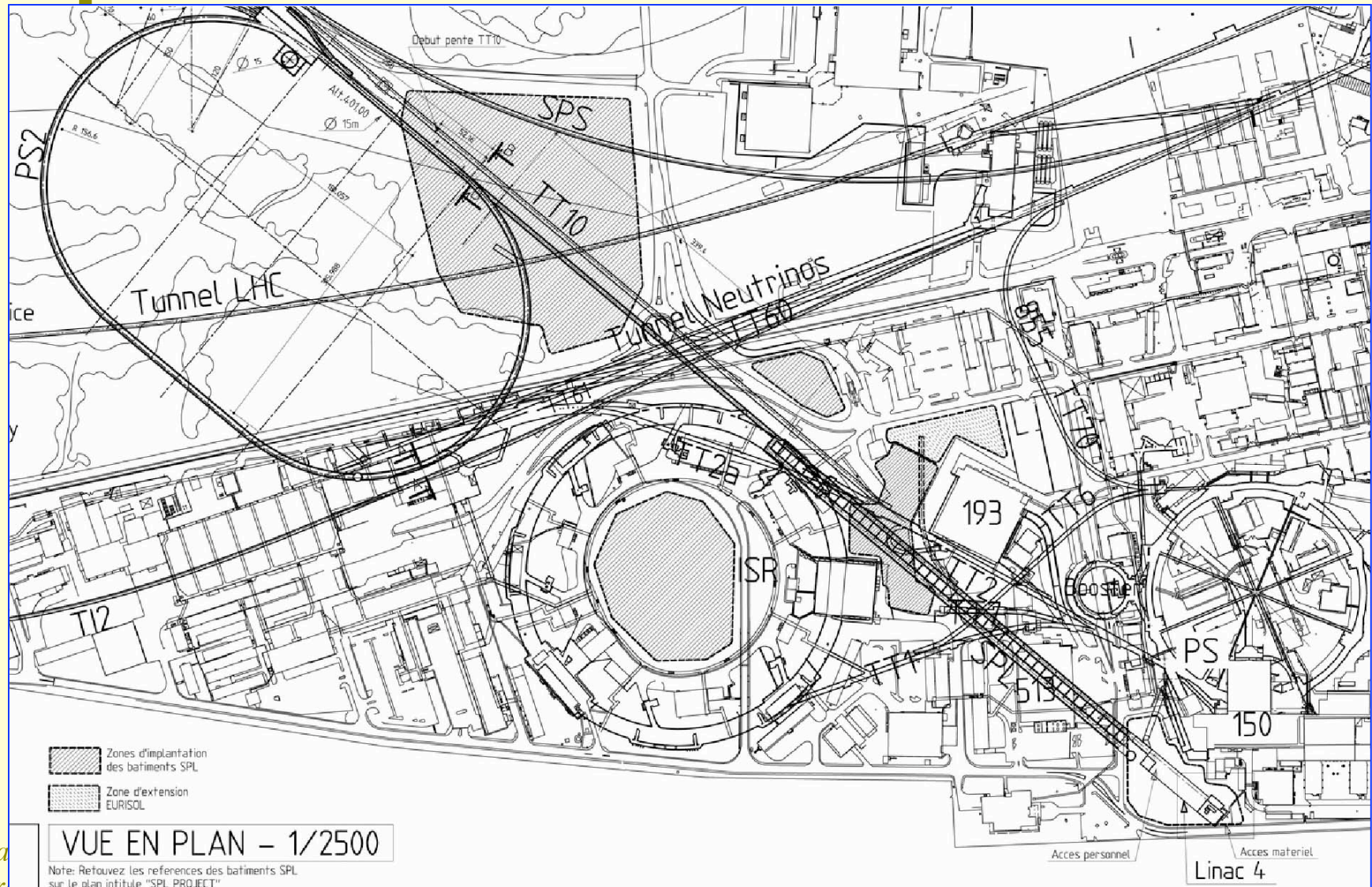
# LARP PS2 Task: the Beginning

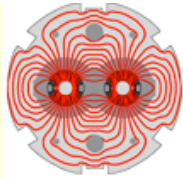
- PS2 high on CERN's priority list
  - LARP built up collaboration
    - 4 tasks ended up with funding
      - Space-charge simulations (LBNL, FNAL)
      - e-cloud simulations (LBNL, SLAC)
      - Impedance and instability evaluations (SLAC)
      - Bunc-by-bunch feedback design/specs (SLAC)
    - Some ended up not being pursued
      - Laser stripping (deemed not req'd by LHC upgrade)
      - IPM (BNL-FNAL-SLAC, but BNL leader reassigned and FNAL at the time already oversubscribed)
  - FY2010 first year with significant funding for the tasks.



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# PS2 Location





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# PS2 Parameters

Circunference	m	1346.4
Harmonic Number		180
Number of bunches		168
Bunch spacing	ns	25
RF Frequency	MHz	40
Transition gamma		26i
Injection Energy	GeV	4
Extraction Energy	GeV	50
Max Bending Field	T	1.7
Max Gradient	T/m	15.5
Ramp time	s	1.2
Cycle time	s	2.4
Horiz. Tune		11.8
Vertical. Tune		6.71
Dipole length	m	3.7
Beta max	m	60
Dispersion max	m	3.3
Chamber half width	cm	6.3
Chamber half height	cm	3.25
Chamber wall thickness	mm	2
Chamber material		SS 316LN
Chamber shape		superelliptical, n=3



## Why is LARP Interested in Injector Upgrades?

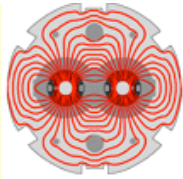
- Most important aspect: Preserve, apply and expand our abilities and expertise.
- Build on expertise at the LARP laboratories
  - Impedance, feedbacks (SLAC)
  - Simulations, space-charge (LBNL, Fermilab)
  - e-cloud work, BI (all 4)
  - ...
- Synergy with FNAL Project X work
  - in particular rf, vacuum
- Fit into LHC upgrade plans





# Brief Status & Results

- e-Cloud effort in good shape
  - build-up simulation effort (Furman) mostly complete,
  - analytic work (Venturini) ongoing.
- Space-charge work in full swing
  - Qiang doing the majority of the work using IMPACT
    - code mods complete, production running
    - strong synergy with SciDAC, Compass
- Impedance work progressing
  - Basic vacuum chamber & some inserts done
  - but really need more input from CERN
    - this info does not really exist.
- Feedback task not really started
  - needs input from rf cavity, only now being developed
- ~~3~~ 4 iPAC papers presented



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# iPAC Papers Published (PS2)

## TUPD020 Studies of Space Charge Effects in the Proposed CERN PS2

- **J. Qiang**, R.D. Ryne  
LBNL, Berkeley, California
- R. De Maria  
BNL, Upton, Long Island, New York
- A. Macridin, P. Spentzouris  
Fermilab, Batavia
- Y. Papaphilippou  
CERN, Geneva
- U. Wienands  
SLAC, Menlo Park, California

## MOPD017 Impedance Considerations for the Design of the Vacuum System of the CERN PS2 Proton Synchrotron

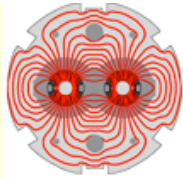
- **K.L.F. Bane**, G.V. Stupakov, U. Wienands  
SLAC, Menlo Park, California
- M. Benedikt, A. Grudiev, E. Mahner  
CERN, Geneva

## TUPD018 Electron-cloud Build-up Simulations in the Proposed PS2: Status Report

- **M.A. Furman**  
LBNL, Berkeley, California
- R. De Maria, Y. Papaphilippou, G. Rumolo  
CERN, Geneva

## TUPD072 E-cloud Driven Single-bunch Instabilities in PS2

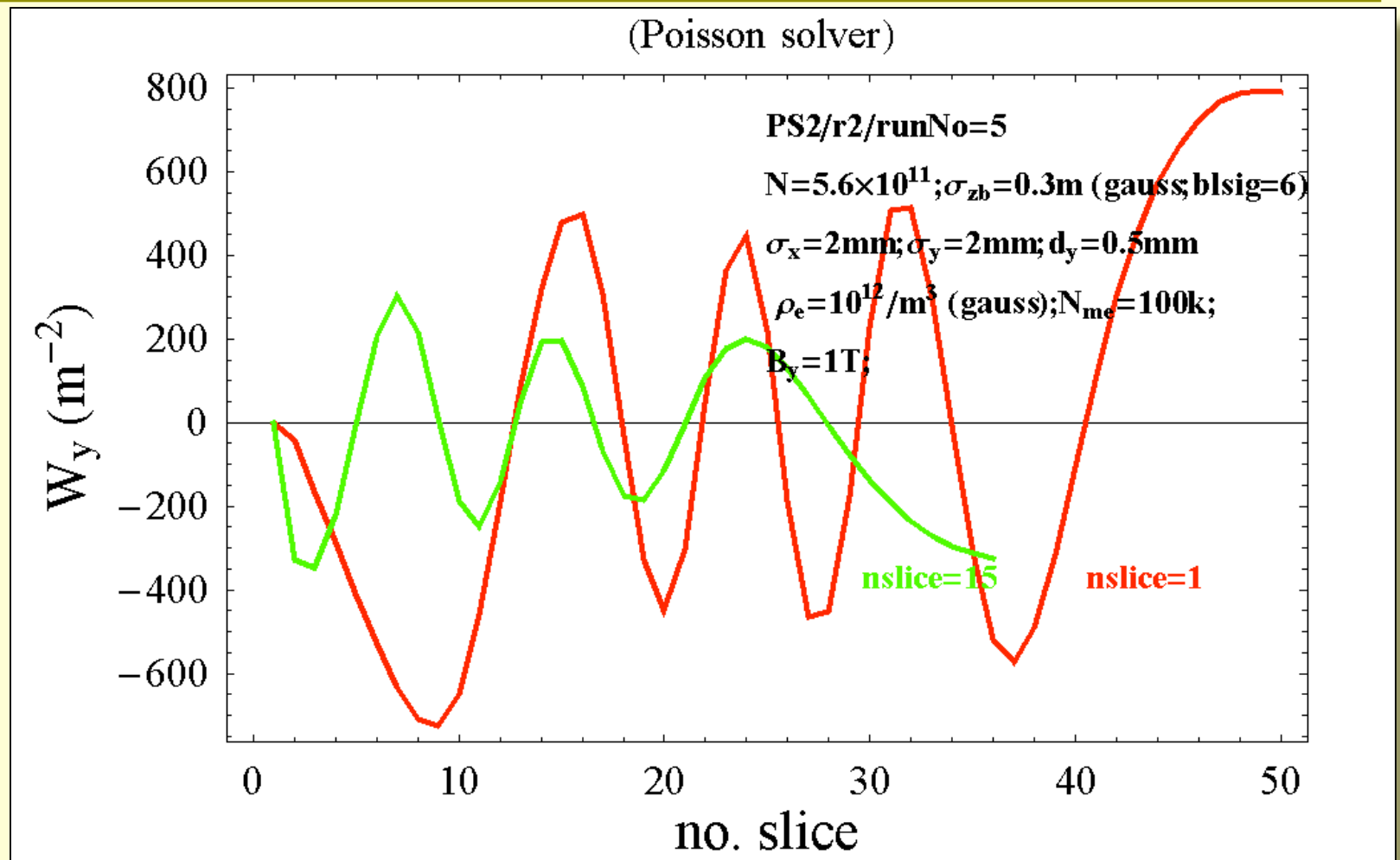
- **M. Venturini**, M.A. Furman, G. Penn, R. Secondo, J.-L. Vay  
LBNL, Berkeley, California
- R. De Maria, Y. Papaphilippou, G. Rumolo  
CERN, Geneva

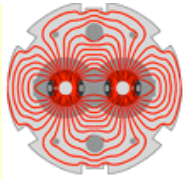


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# Results e-Cloud

Venturini et al.

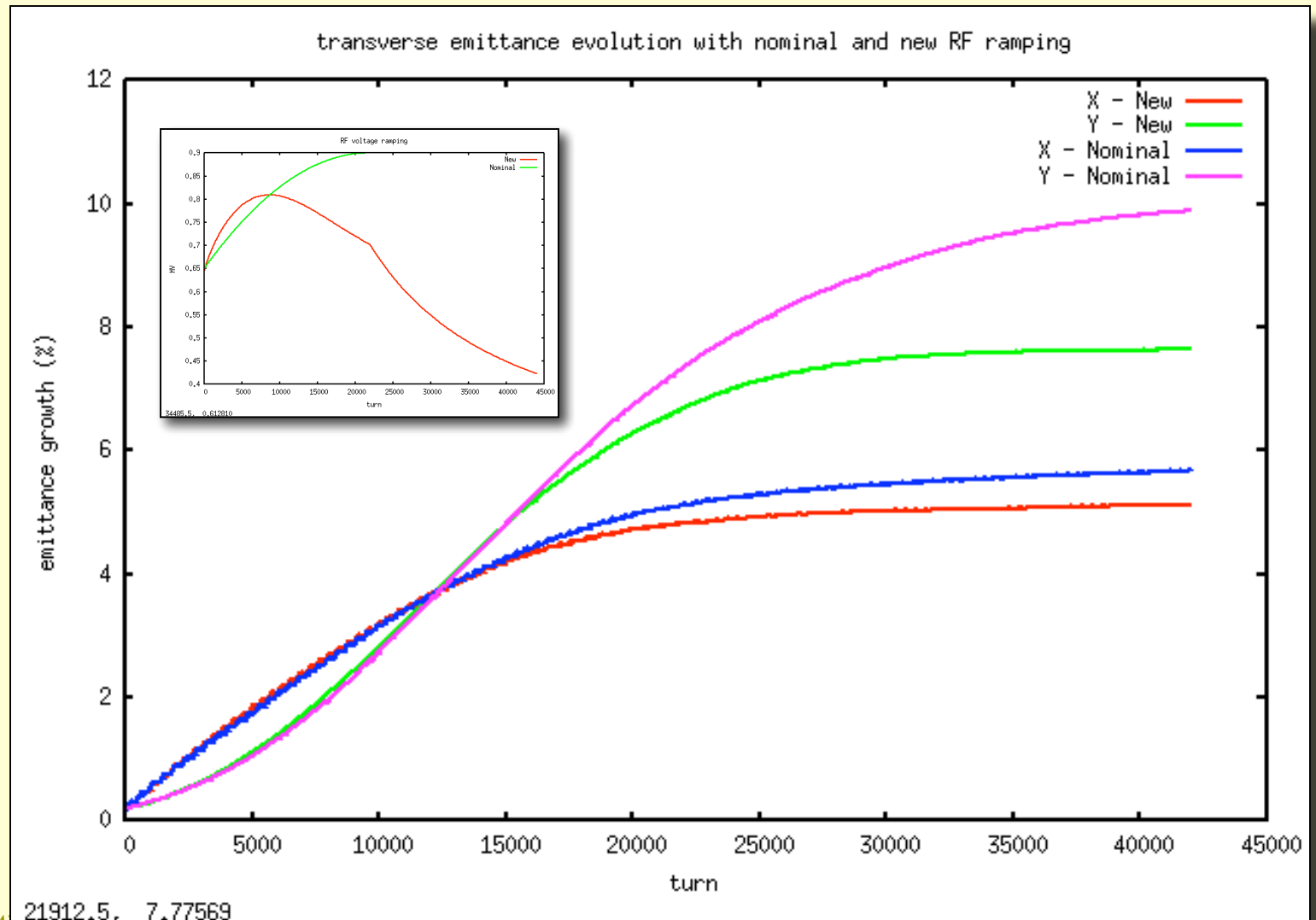




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# Results Space-Charge

Qiang, Ryne



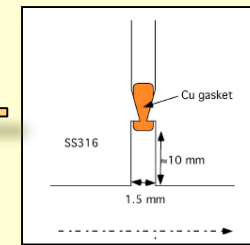
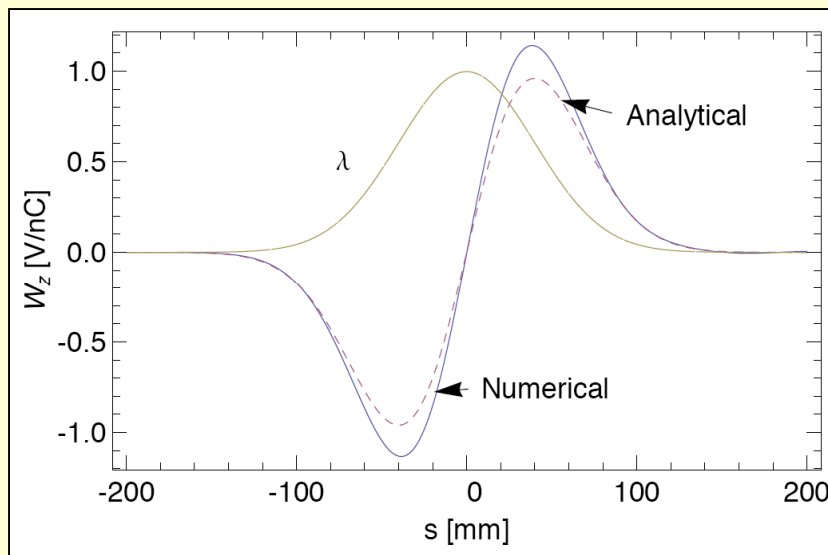
U. Wienands, SLAC  
LARP Program Review





# Results Impedance

Bane et al.



Wakefield of an unshielded ConFlat Flange

Impedance summary up to now

Table 2: Impedance budget for the PS2, including objects considered so far, assuming no Cu plating of the beam pipe.

Item	$Z/n$ [ $\Omega$ ]		$k_y$ [V/pC/m]	
	Inj.	Extr.	Inj.	Extr.
RW	$0.39(1 - i)$	$0.20(1 - i)$	24	47
Flanges	$-0.17i$	$-0.17i$	5	19
SC	$50i$	$0.5i$		
Total	$0.39+49i$	$0.20+0.13i$	29	66

# People in charge...

1. **Introduction**
2. **Optics, beam dynamics and operation aspects**
3. **Technical Systems**
4. **Site aspects, buildings and technical infrastructure**

Responsible	Chapter
Michael Benedikt	Introduction, basics design choices and general parameters
Yannis Papaphilippou	Ring lattice, linear and non-linear optics & corrections, dynamic aperture
Brennan Goddard	Injection, extraction and transfer lines
Steven Hancock	Longitudinal dynamics
Uli Wienands	Beam stability, collective effects, impedances
Thomas Otto	Beam loss management and radiation protection aspects



# Post-Chamonix World

- At Chamonix and thereafter: CERN decided to reorient the injector upgrade work
  - Need for upgrades not being questioned, but opinion prevailed that upgrade of extant chain is more cost-efficient.
  - PSB 2 GeV upgrade centerpiece
  - Interest by CERN in continuing LARP collaboration for injectors (Heuer, Myers).
  - PS2 Design Report will be completed end CY2010.
- How and where does it make sense to reorient ourselves?



# Scheme for the Injector Upgrades

- Linac 4 already under construction
  - raises PSB space-charge limit at injection=>brightness
- The PSB is to be upgraded to 2 GeV extraction energy to relieve the PS limitations @ injection
- PS has possible limitations at extraction due to TMCI and/or e-cloud.
  - fully commission TFB system.
  - possibly install new/upgrade LFB system.
- Limits in the SPS are mostly by e-cloud
  - upgrade vacuum system,
  - build e-cloud feedback (if possible),
  - upgrade of certain hardware (ZS)
  - collimation?



# Some Upgrade-related Details

- A lot of the PSB upgrade involves new power supplies.
  - CERN would love to receive “help” with this (\$\$)
  - Not well suited to LARP (no R&D but spec. & procure)
- The big SPS challenge is coating the vacuum system (a-C preferred option right now)
  - Could have synergy with Fermilab MI plans for PrX
  - Discussions FNAL-CERN outside LARP.
  - This should be seen complementary to any feedback solution.
- There are other challenges like ZS upgrade
  - mostly design & build, rather than R&D.
- Then, there is MD support
  - excellent fit to LARP LTV and Toohig-fellow program.





# LARP Injector task: Future

- There is significant interest at CERN in getting better beam-profile monitoring in PSB & PS (@CERN: Tan)
  - Trying again to see whether LARP wants to get into the action.
    - LBNL has resources available
    - CERN interest stronger, we have a draft spec. sheet, CERN poc.
  - Would like to initiate a study (1 year) and then decide about prototyping.
    - Study would identify technology and provide conceptual design
  - Explored designing wideband cavity kicker for PS lfb: not ready as the benefits are not clear.



J.Tan BE/BI, K.Hanke BE/OP

## Functional Specifications for a turn-by-turn profile monitor for the CERN PS Booster

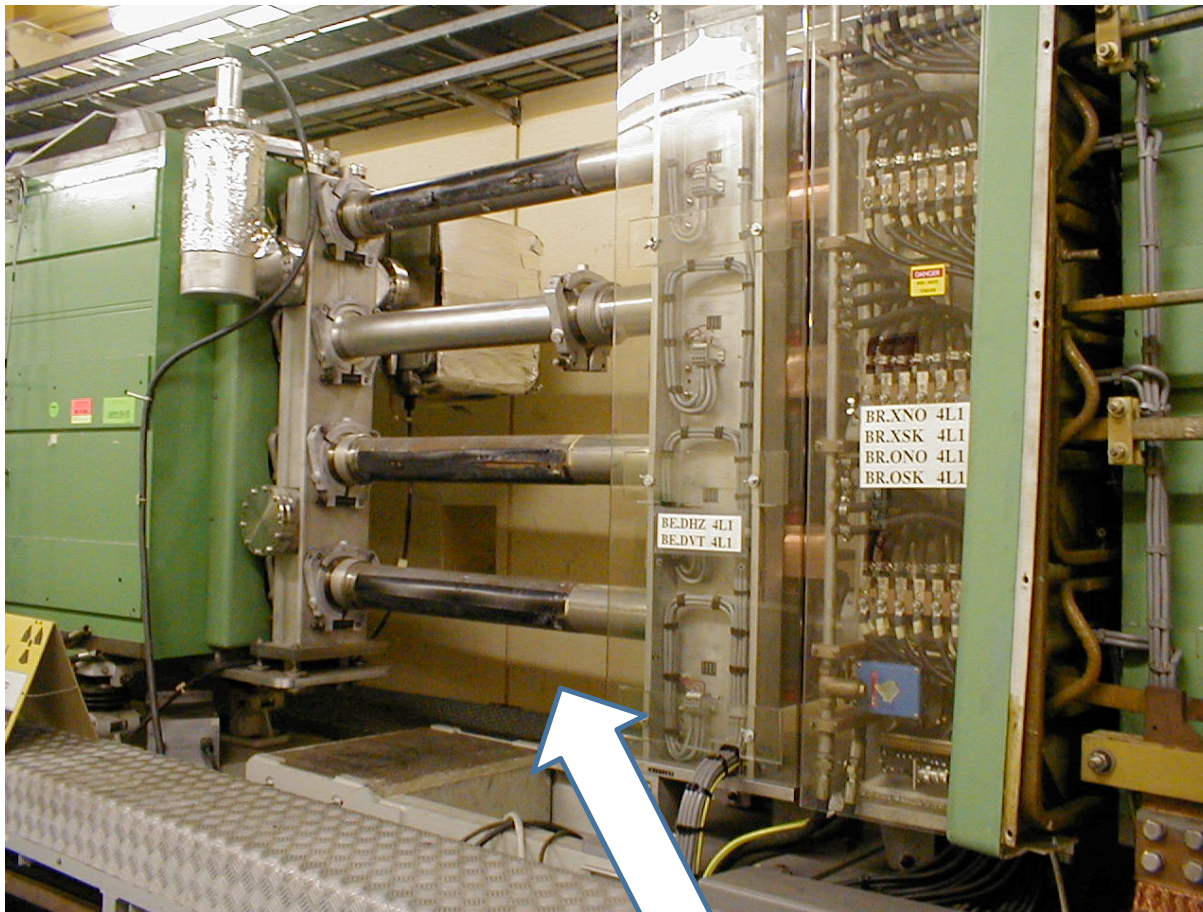
### Introduction

In the frame of the Booster upgrade to 2 GeV , we propose to develop a turn-by-turn beam profile monitor. The development and construction would be a contribution of the US LARP program, based on specifications defined by the PS Booster upgrade working group and the CERN BE/BI group. This document outlines the functional specifications for such a device.

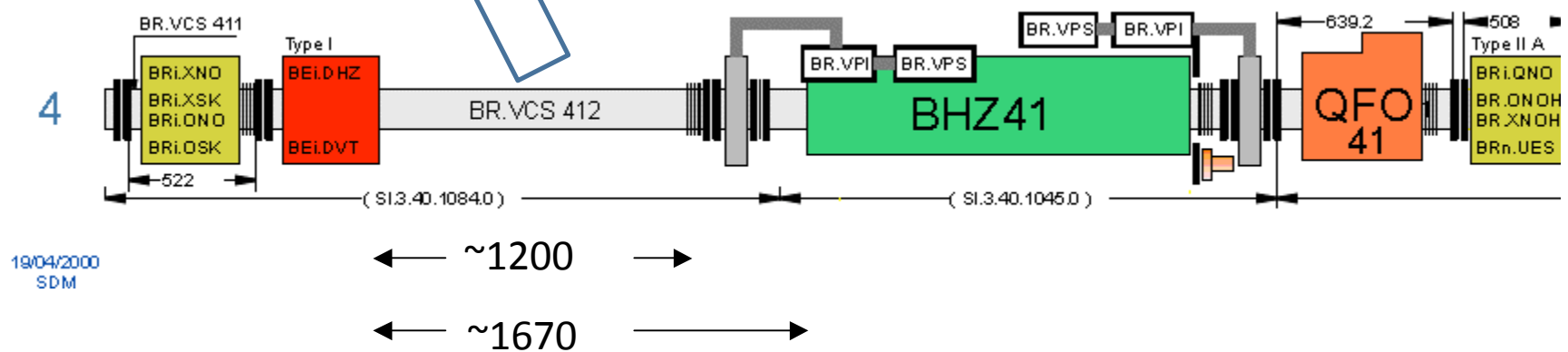
### Functional Specifications

1. Read-out: turn-by-turn. Revolution frequency
  - at 50 MeV (present injection energy)  $\sim 0.6$  MHz,
  - at 160 MeV (injection energy with Linac4)  $\sim 1$  MHz
  - at 2 GeV ( top energy after upgrade)  $\sim 1.81$  MHz
    - o In case of memory problems, a floating window measuring a certain number of turns could be envisaged.
2. If a turn-by-turn feature is not feasible, a time resolution of 10 ms is also interesting for observing the evolution of the emittance along the acceleration cycle.
3. 1 or 2 bunches per ring
4. planes: horizontal and vertical simultaneous
5. rings: all 4 rings H+V (8 devices in total)
6. beam spot size smallest:  $\sim 1.4$  mm x 1.4 mm (LHC PROBE at extraction)
7. intensity dynamic range: smallest intensity  $5E9$  protons/ring; highest expected intensity  $1.4E13$  protons/ring (if only the LHC upgrade is considered, then the highest expected intensity would be  $2.5E12$  for the ultimate bunch intensity or  $3.3E12$  for the nominal LHC beam in single batch transfer).
8. The injection process at C275 ms lasts actually  $25\mu s$  max per ring. With Linac4 the maximum duration will be  $100\mu s$  per ring. The table below shows the physical beam size measured with the Fast Wire Scanner after the injection process. From these figures, one can specify a spatial resolution of 2% rms for the IPM.

	LHC PROBE : $1.5E10$ protons		LHC25 : $165E10$ protons	
[ms]	H( $1\sigma$ ) [mm]	V( $1\sigma$ ) [mm]	H( $1\sigma$ ) [mm]	V( $1\sigma$ ) [mm]
C276	5	4.5	NAN	NAN
C280	NAN	3.9	7.9	5.7
C290	4.1	3.8	8	5.7
C300	4	3.6	8	5.9



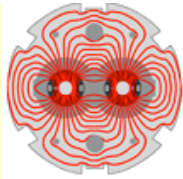
A stack of four rings,  
spaced by 360mm





## LARP Injector task (cont'd)

- A direct synergy was found for the space-charge simulation (@ CERN:Carli):
  - limits of PSB with Linac 4 not really understood
  - chance to benchmark codes with present L2 (50 MeV)
  - strong interest at LBNL to pursue this.
- There is also strong interest in continuing the e-cloud program
  - Strong scientific collaboration
  - SPS and PS both will need continuing attention
  - Presently funded under a separate LARP task #.

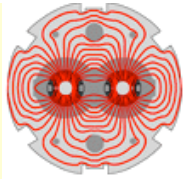


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# Effort Estimate

			FY11						
Project (PS2)			PersonYear	tot	SLAC	LBNL	FNAL	BNL	Travel & M&S
			0.0			0.0			
	Space-charge tracking, collim		0.3		0.0	0.30	0.00		\$ 5
	Instability		0.3		0.3	0.0	0.0		\$ 5
	e-cloud		0.2		0.0	0.2			\$ 5
	Feedbacks		0.2		0.2				\$ -
			0.0		0.0			0.0	\$ -
	Total FY11		1.0		0.45	0.5	0	0	\$ 15
			FY11 New Inj. Projects						
Project (Injectors)			PersonYear	tot	SLAC	LBNL	FNAL	BNL	Travel & M&S
			0.0			0.0			
	Space-charge PSB		0.8		0	0.8	0		\$ 5
			0.0		0	0.0	0		
	e-cloud (SPS)		0.0		0	0.0			\$ 5
			0.0		0	0.0			
	IPM PSB		0.7		0.1	0.4	0.2	0	\$ -
	Total FY11		1.5		0.1	1.2	0.2	0	\$ 10
			FY12 New Inj. Projects						
Project			PersonYear	tot	SLAC	LBNL	FNAL	BNL	Travel & M&S
			0.0			0.0			
	Space-charge PSB		0.5		0	0.5			
			0.0		0	0.0	0		
	e-cloud (SPS)		0.0		0				
			0.0		0	0.0			
	IPM PSB	w/o M&S	1.7		0.2	1.0	0.5	0	\$ ???
	Total FY12		2.2		0.2	1.5	0.5	0	\$ -





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# Conclusion

- Wrap up PS2 work and write/edit report section
  - writing by task persons, editing by UW
  - 1st draft due by 30-Sept-2010
- In rough terms, need 1/4 year of support for this in FY11, or about 1 FTE.
- We are developing proposals for follow-on work on the injector chain
  - Space-charge tune shift, incl. painting, in PSB
  - Profile monitor study.
  - Expect about 1.5 FTE worth of effort.
    - The SPS e-cloud & feedback efforts are ongoing also, on different task #s